Best Practices in Defense Technology Development and Technology Maturity Assessments

Systems & Software Technology Conference (SSTC)

28 April 2010

Mr. Jeffrey Craver

Defense Acquisition University

Lt Col Dian Hall

DTRA-RD

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Presentation Objectives

- Describe the problem space – ***Why are we here?***
- Describe a solution set focused in the ***Technology Program Management Model (TPMM)***
- Describe how to ***change the culture*** of an S&T enterprise
- Discuss the ***installed base*** for TPMM
- Use the ***TPMM Implementation Project at DTRA*** to illustrate how organizations can take

Demonstrate how one solution developed out of necessity at the Army Space and Missile Defense Command has captivated the attention of the Defense Acquisition University and changed the landscape for S&T

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Quantifying the Effects of Immature Technologies

According to a GAO review in 2005 of 54 DoD programs:

- **Only 15% of programs began System Design Decision [post MS B] with mature technology (TRL 7)**
  - **Programs that *attempted to integrate with immature technologies* averaged *41% cost growth* and a *13 month schedule delay***
- **At Critical Design Review, 58% of programs demonstrated design instability (< 90% drawings releasable)**
  - ***Design stability not achievable with immature technologies***
  - **Programs *without stable designs at CDR* averaged *46% cost growth* and a *29 month schedule delay***

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Source: Defense Acquisitions: Assessments of Selected Major Weapon Programs, GAO-05-301,

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5 Reasons Why This Happens

- ***Doctrine*** **Promotes delay**
  - **The DoD 5000 doesn't call for the first Assessment of the technology until MS-B (too late in the process to have any real effect on an immature technology)**
- ***Predisposition*** **of Viewpoints**
  - **Users know the requirements, Acquisition Managers know how to build things, and Technology Developers know how to invent.**
  - **A Forcing Function is needed to effectively cross those boundaries**
- ***Communication*** **Breakdown**
  - **Tech solutions selected to fill gaps need continual re-alignment to ensure development is on schedule and that the "right" problem is still being solved**
- ***Culture*** **Within the Technology Development Community**
  - **Tradition of Invention and scientific endeavor in the Technology Community contributes to a lack of Transition Focus**
- ***Interpretation*** **Wide Enough to Drive a Humvee Through**
  - **TRL definitions are vague and sometimes too subjective which can**

One Conclusion: A System Engineering and Programmatic-based criteria set needs to be applied as a standard earlier in the process.

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Observation: Common Challenges Facing Most Tech Directors

Effectively *managing technology development*

- **Programmatic problems**
- **Lack of Systems Engineering Principles**

Successfully *transitioning technologies*

- **Transition not considered as part of Tech Dev**
- **Lack of Customer/User**

I don't so much care what the answer is so long as the Technology Manager has asked himself the question!

J. Granone ***(Former Director - USASMDC)***

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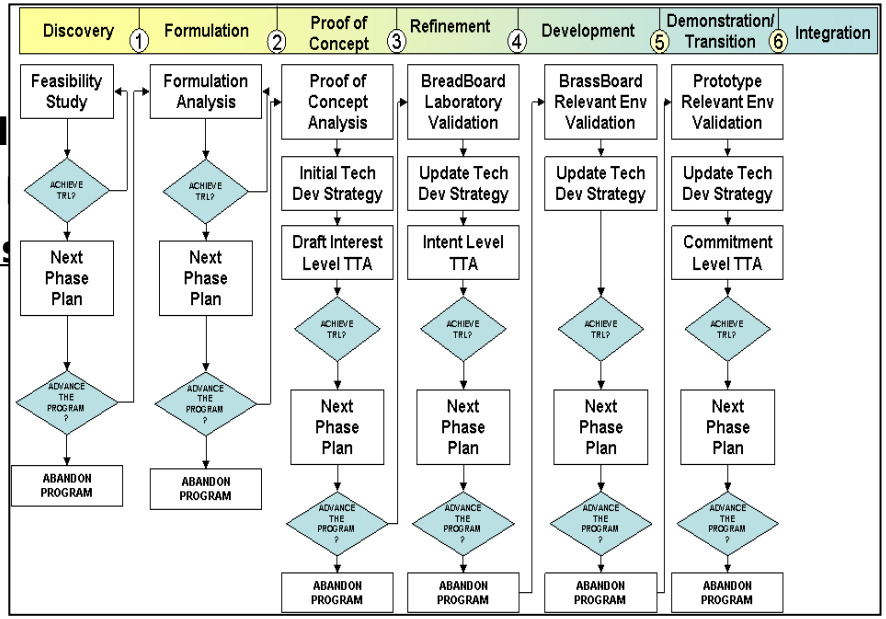
The Functions Performed by TPMM

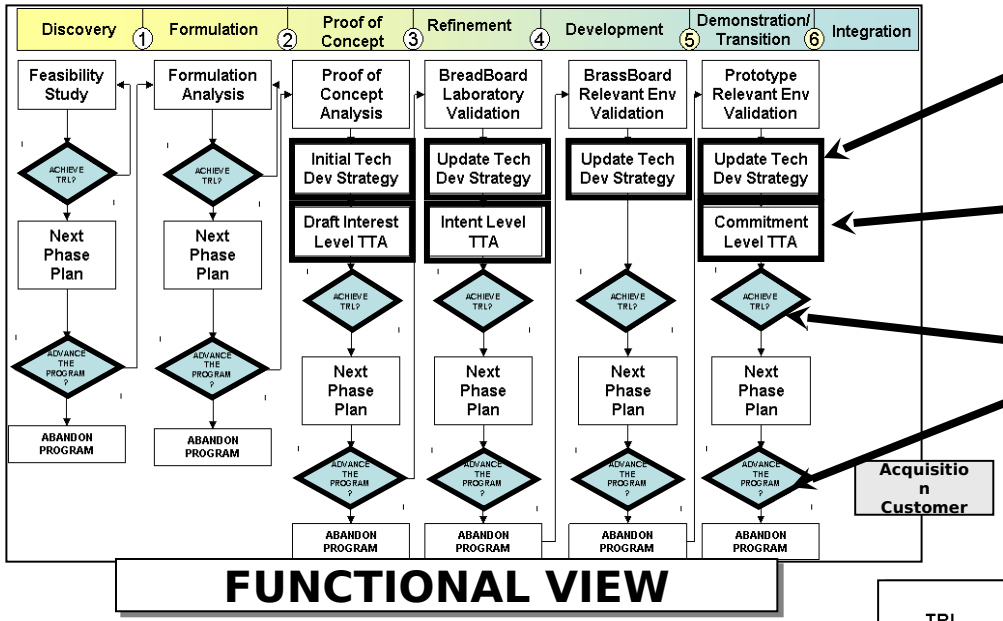
A TRL-based, Stage Gate Model that Assists:

- **Program Definition**
  - Identify Activities that will be performed
  - Identify Documents that will be produced
  - Provide an Environment for Tailoring the
  - Develop and Employ "Best Practice" Tools
- **Transition Management**
  - Technology Transition
  - Technology Transfer
  - Technology Marketing
- **Maturity Assessments**
  - Establishes Entry/Exit Criteria - Tailored for each Project
  - Provides a Framework for Performing Technology Readiness Assessments (TRA)



"TPMM: A Model Designed for Technology Development and Transition"

Key Features of the Multi-Dimensional TPMM



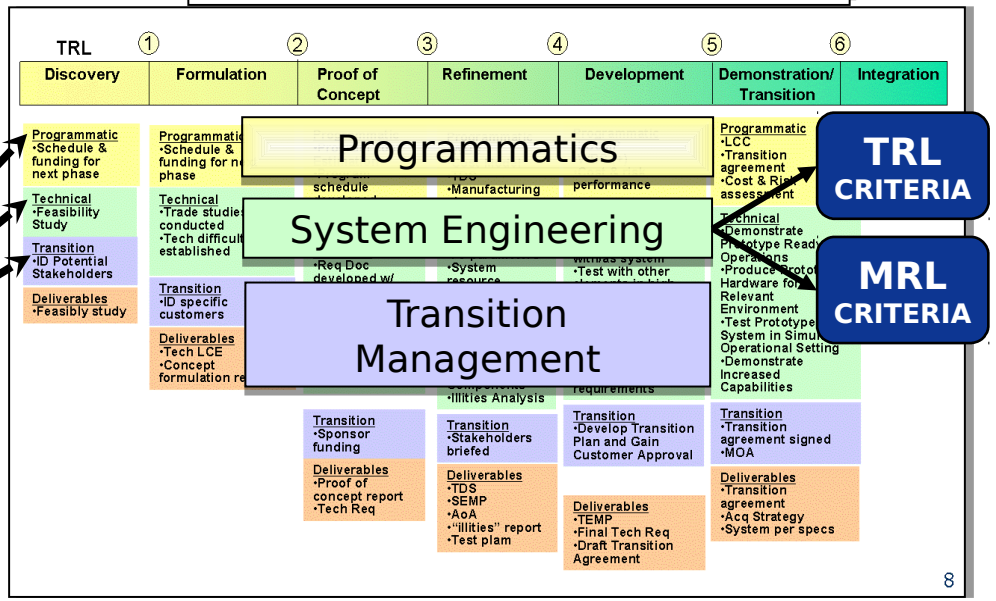
FUNCTIONAL VIEW

TDS establishes common language and vision

DAU adopted TTA

Program reviews include a TRA and a TAA

ARCHITECTURAL VIEW



Multi-Dimensional criteria set provides a comprehensive TRL Assessment

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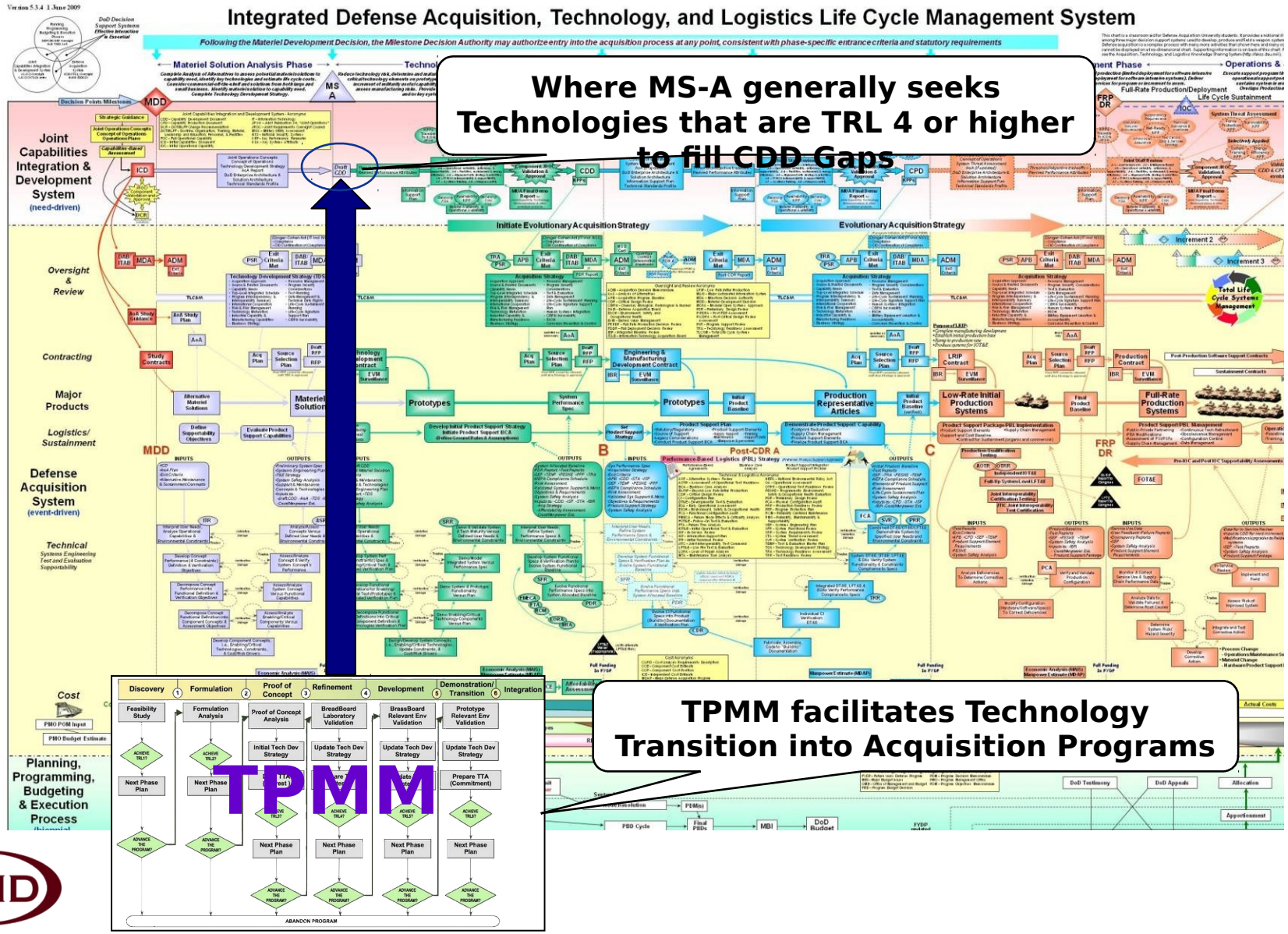
TPMM Supports DoD 5000 Alignment

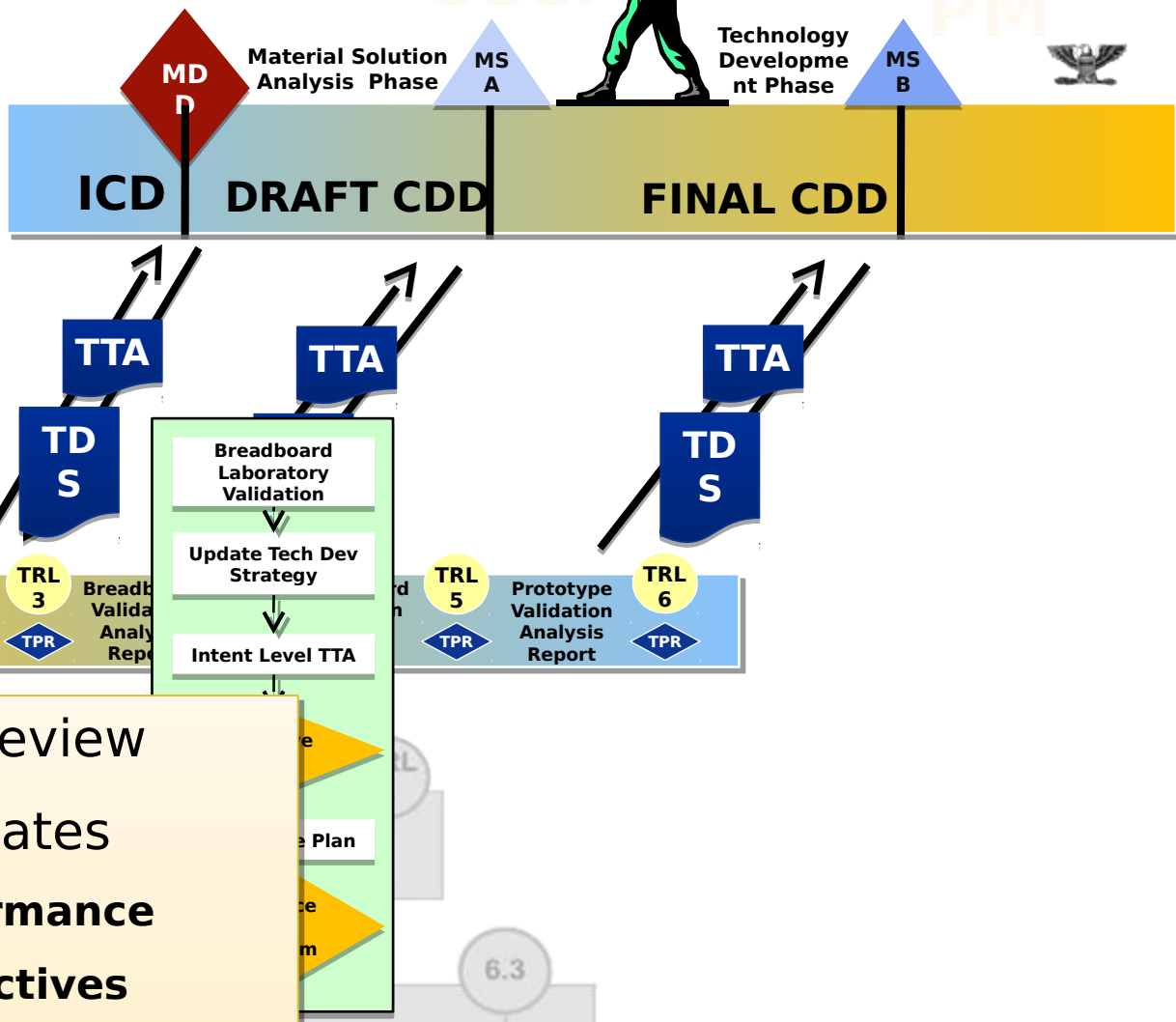


Where MS-A generally seeks Technologies that are TRL 4 or higher to fill CDD Gaps

TPMM facilitates Technology Transition into Acquisition Programs

Alignment Mechanisms Facilitate Effective Communication

TPMM defines the process and transition mechanisms to help tech programs align with Acquisition Milestones



Gate Review

Evaluates

- **Performance Objectives**
- **Alignment Mechanisms**
- **Next Phase Plan**

S&T

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TPMM Support to Decision-makers

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TPMM Strategic Value

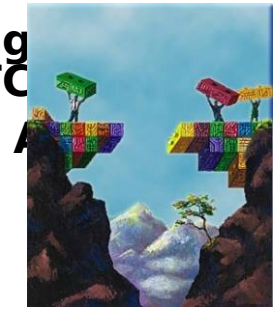
Captures the Enterprise View of Technologies in S&T

Status of Programs

- **Standardizes Progress in Meeting TRL Maturity Goals**
- **Transition Agreements in place**
- **Successful Transitions over time**
- **Program Distribution by**
  - **TRL**
  - **Technology Domain**
    - **Science Discipline**
    - **Sponsor**
  - **Acquisition Customer**
  - **Funding**

Facilitate Strategic Planning

- **Technology Distribution and Prioritization**
- **Technology Development Gap Analysis**
- **Domain Analysis**
  - **Skill gaps / recruiting (Develop/Maintain TC**
  - **Diversified Portfolio A**
    - **Sponsor**
    - **Science Discipline**
- **TTA Migration Status**
- **Develop POM/Budget Inputs**
  - **Substantiates Technology maturity and value**



TPMM Provides a Metrics-driven Process that Supports Strategic Decision Making

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Program/Project Status Quad Chart (Notional Tech Program Metrics)

Program Description

Description

- Executive summary
- Validated Need
- Significance to End User

Current Technical Status

TRL Rating Based on TPMM

- TPMM Phase
- Required Criteria Met/Not-Met
- Gap Analysis (on Un-Met)

Cost & Schedule Progress

Technology Development Strategy

- Schedule Milestone Items
- Cost vs. schedule

Risk

- Risk Assessment on Gaps

Program Vision to Transition

TRL Roadmap

- TRL Milestone Schedule to transition

Transition Management

- Customer/User/Sponsor ID'd
- TTA Version (Interest, Intent, Commitment)

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Government Agency/ Program TPMM Users

Missile Defense Agency
- **Kill Assessment Technology Program used TPMM to broker the inclusion of their technology concept into the C2BMC Element of the BMDS.**

Department of Homeland Security
- **Provided Basic Research technology maturity data (Entry/Exit Criteria, Phase Deliverables, and Activities) used to populate the Exploratory portion of their draft S&T RDT&E Process.**

Air Force (AFMC at Wright-Patterson AFB)
- **Supporting TD-1-13 Initiative: High Confidence Technology Transition Planning Through the Use of Stage-Gates (More later)**

U.S. Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT)
- **Vertical/horizontal Integration of Space Technologies and Applications (VISTA) Program**
- **Distributed Imaging Radar Technology (DIRT)**
- **All Weather RF Launch Detection (AWRFLD)**

Defense Acquisition University (Huntsville Campus)
- **Developing an interface between Technology Assessment and Transition Management (TATM tool used at PEO Aviation) and TPMM.**

Defense Threat Reduction Agency (NTD Ft. Belvoir)
- **Providing Engineering Analysis to initiate collaboration on a Technology Management Process Improvement effort designed to implement the TPMM**

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DTRA RD TPMM Implementation Pilot

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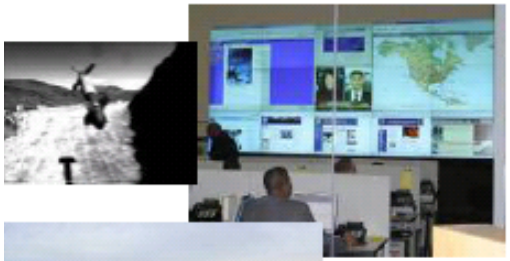
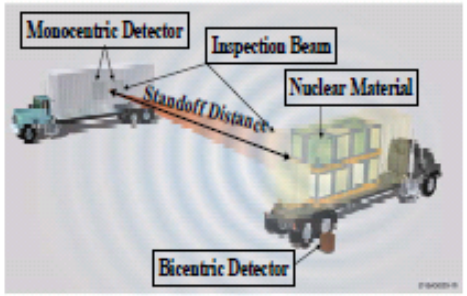
Defense Threat Reduction Agency

Making the world safer...

...by countering weapons of mass destruction

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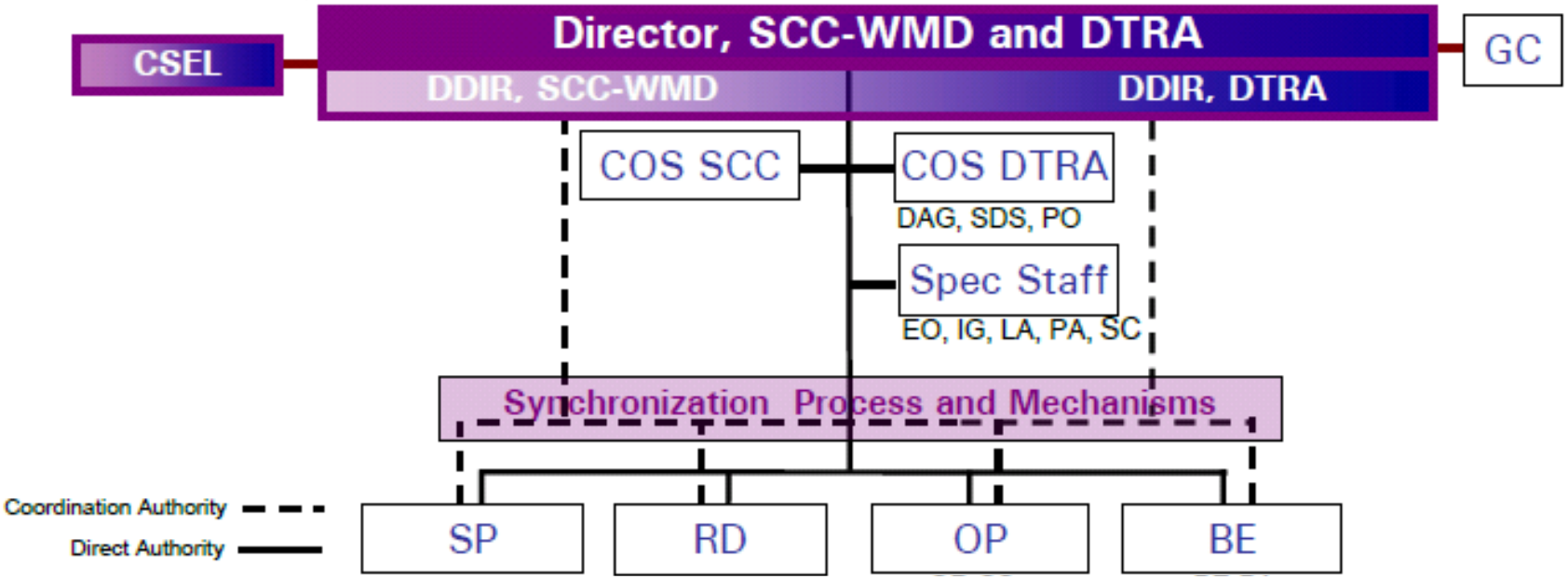
DTRA Organization



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Challenges Facing an RD-NT Tech Director

Effectively *managing technology development*

- **Programmatic problems**
- **Lack of Systems Engineering Principles**

Successfully *transitioning technologies*

- **Transition not considered as part of Tech Dev**
- **Lack of Customer/User**

***Establish* "a management methodology that balances the portfolio by *Imposing Structure and Rigor* *through the use of clear, well-defined and Measurable Metrics*!"**

***J. Heusmann DTRA-RD-NT* (7 May 09)**

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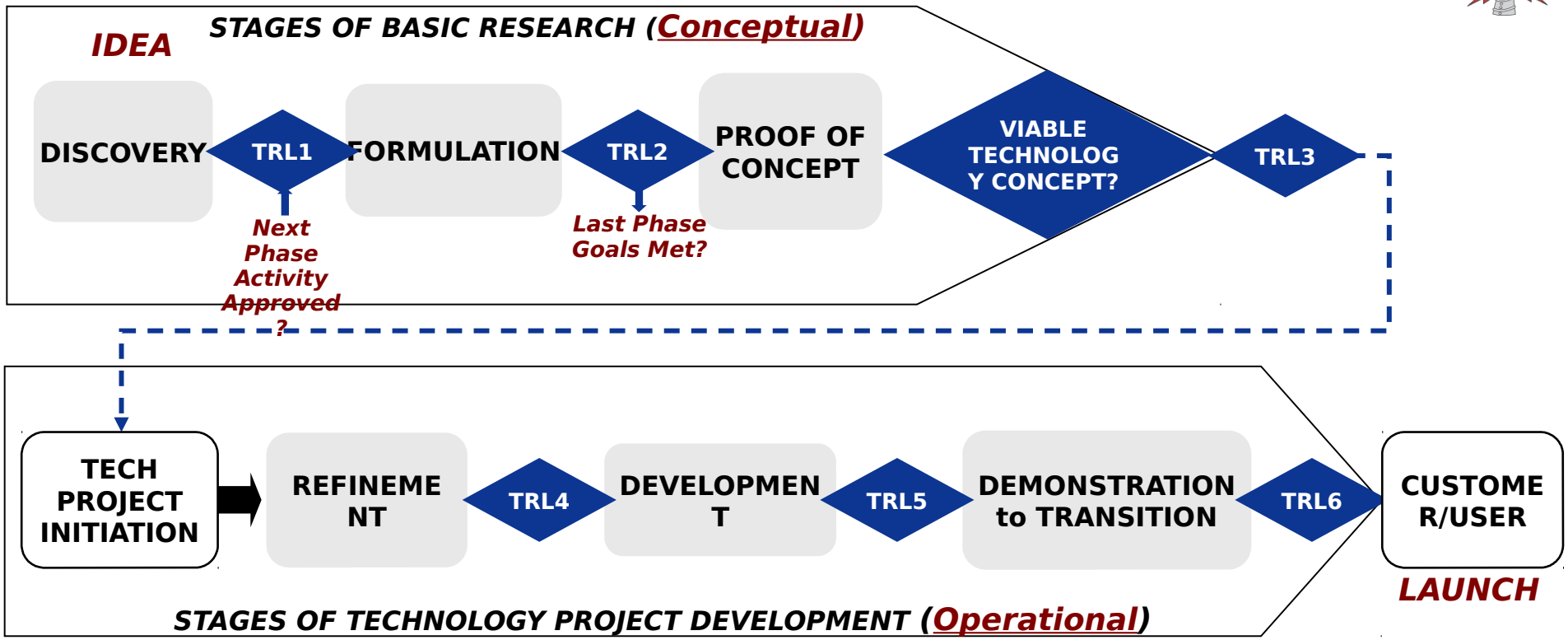
Introducing Stage-Gate



Process Represented by:

- Distinct Blocks for ***Conceptual*** and ***Operational*** development paths that when combined, traverse from ***Idea*** to ***Launch***.
- Managed process of ***Defined Stages*** composed of ***Activities/Tasks*** that are evaluated as input criteria for planning/approval to ***proceed to the next stage***.
- Stages culminate in ***Decision Gates*** of measurable Exit Criteria used to evaluate technical accomplishment and technology readiness/maturity ***(TRL)***.

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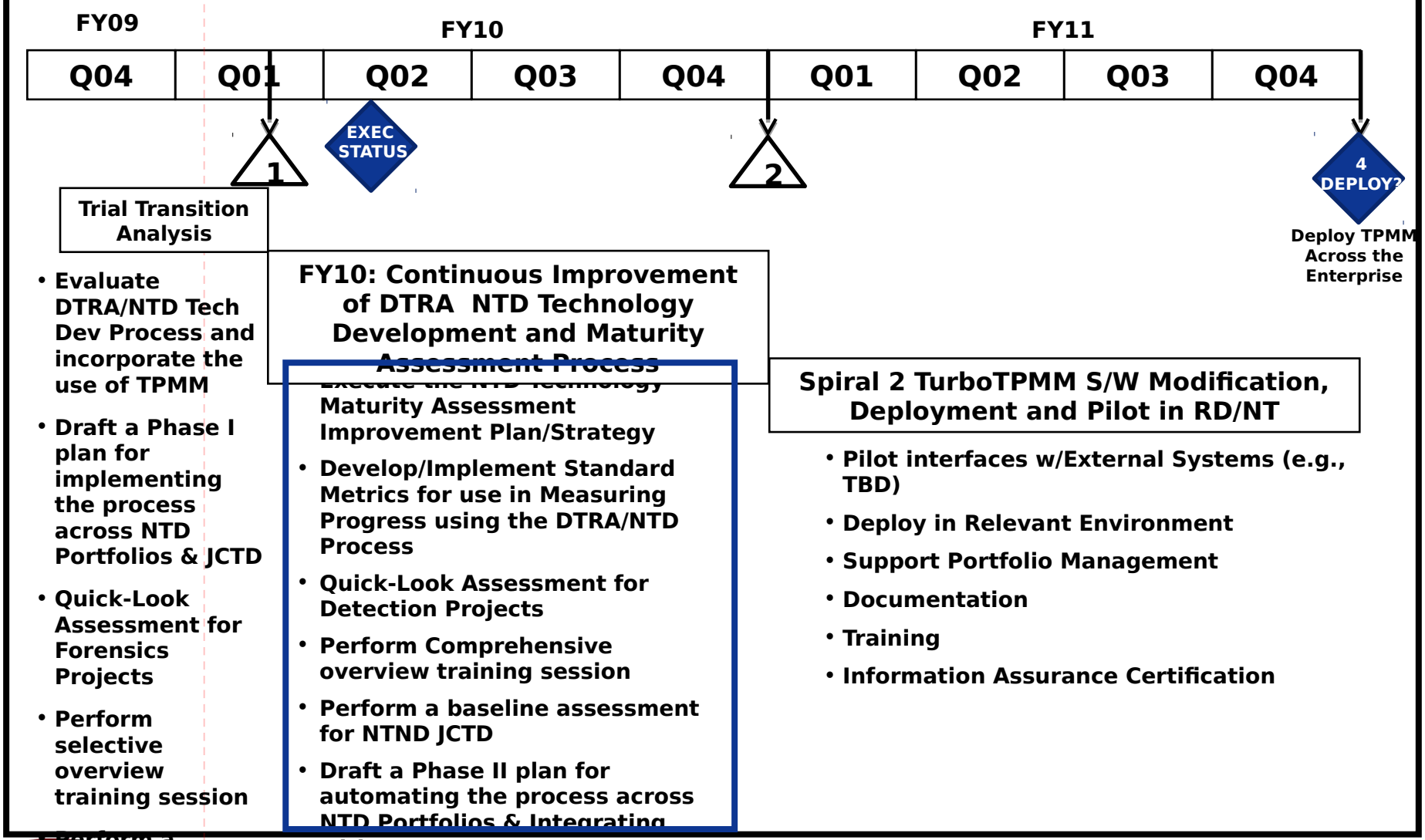
Current Plan for TPMM Implementation in DTRA/RD-NT


FY09
FY10
FY11
Q04
Q01
Q02
Q03
Q04
Q01
Q02
Q03
Q04
1
EXEC STATUS
2
4 DEPLOY?
Deploy TPMM Across the Enterprise
Trial Transition Analysis
• Evaluate DTRA/NTD Tech Dev Process and incorporate the use of TPMM
• Draft a Phase I plan for implementing the process across NTD Portfolios & JCTD
• Quick-Look Assessment for Forensics Projects
• Perform selective overview training session
• Perform a baseline assessment for NTNF JCTD
FY10: Continuous Improvement of DTRA NTD Technology Development and Maturity Assessment Process
Maturity Assessment Improvement Plan/Strategy
• Develop/Implement Standard Metrics for use in Measuring Progress using the DTRA/NTD Process
• Quick-Look Assessment for Detection Projects
• Perform Comprehensive overview training session
• Perform a baseline assessment for NTND JCTD
• Draft a Phase II plan for automating the process across NTD Portfolios & Integrating with SE Process at RD/NT
Spiral 2 TurboTPMM S/W Modification, Deployment and Pilot in RD/NT
• Pilot interfaces w/External Systems (e.g., TBD)
• Deploy in Relevant Environment
• Support Portfolio Management
• Documentation
• Training
• Information Assurance Certification

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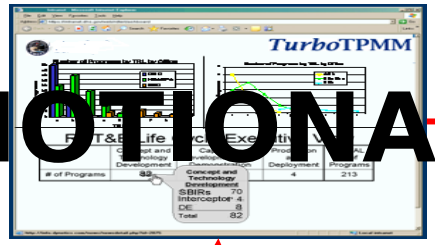
TPMM Implementation Process

Organizational Policy/Standards

KBS

Program Sponsor or Technology Portfolio Mgr

Executive Dashboard



NOTIONAL

QSR

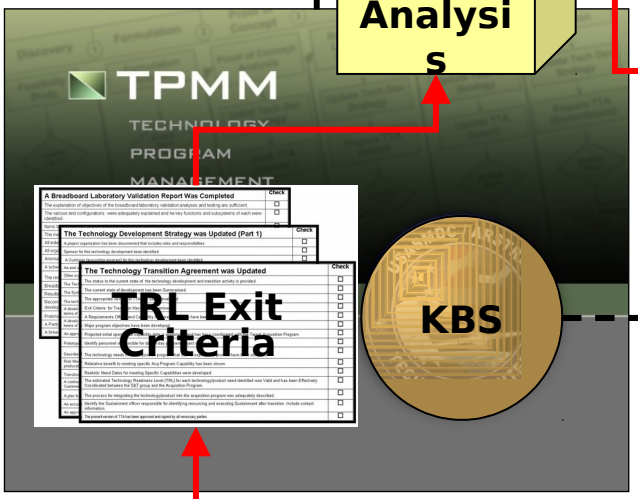
TRL Rating Based on TPMM
• TPMM Phase
• Required Criteria Met/Not-Met
• Gap Analysis (on Un-Met)
• Risk Assessment on Gaps
Current TRL confidence and Statement of Risk
Technology Development Strategy
• TPMM Requirement? (TRL3 or beyond)
• Status = Draft, Preliminary, Final
• Updated for Current Phase?
• Gap Analysis/Percentage Populated
Programmatic Progress
Transition Management
• Customer/User/Sponsor ID'd
• TTA Version (Interest, Intent, Commitment)
• TTA Matrix Populated
• Signature Status
Transition Planning Progress
TRL Roadmap
• TRL Milestone Schedule to transition
• TPR Status
Program Vision to Transition

LEGEND:
Infrastructure:
Status Review:

Technology Maturity Assessment

Primitive Data (as needed)

Gap Analysis



TRL Exit Criteria

KBS

Standards-Based Training Courses

Technology Programs

TRL RM

TDS

TRA

TTA

Performance Quad Preparation Workshops

DMD

Deliverables / Lessons-Learned

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TPMM Implementation Process

After the TMA, the Technology Maturity Level is availabl posted in its P for Executive

Policy/Standards

ard

KBS

Program Sponsor or Technology Portfolio Mgr

LEGEND:
Infrastructure:
Status Review:

At the same time, a critical review of Project Deliverables by subject matter experts will be conducted to verify that agreed-to Exit Review Criteria are met and that identified Risks have been mitigated.

i:ational Policies and Standards:

based behavior forms the basis of the ations' *Knowledge Base* which grows ime as each new Project adds their artifacts and experience.

TRL Rating Based on TPMM

Technology Development Strategy

gy Maturity and Progress:

ntains entry and exit criteria to guide Systems Engineering, Programmatic, and Transition technology development activity

TRL

Gap Analysis

TPMM
TECHNOLOGY
PROGRAM
MANAGEMENT

TRL Exit Criteria

KBS

TPMM V.2
Standards-Based Knowledge Based Training Courses System

Technology Programs

TRL RM | TDS | TRA | TTA

Performance Quad Preparation Workshops

DMD

Deliverables / Lessons-Learned

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Planned TPMM Pilots at DTRA-NT in FY 10/11

Basic Research

- **BA to identify TRL 2/3 opportunities (1 or 2 projects) that BA and NTD will develop a transition plan for FY11 execution .**

NTD TPMM Pilot

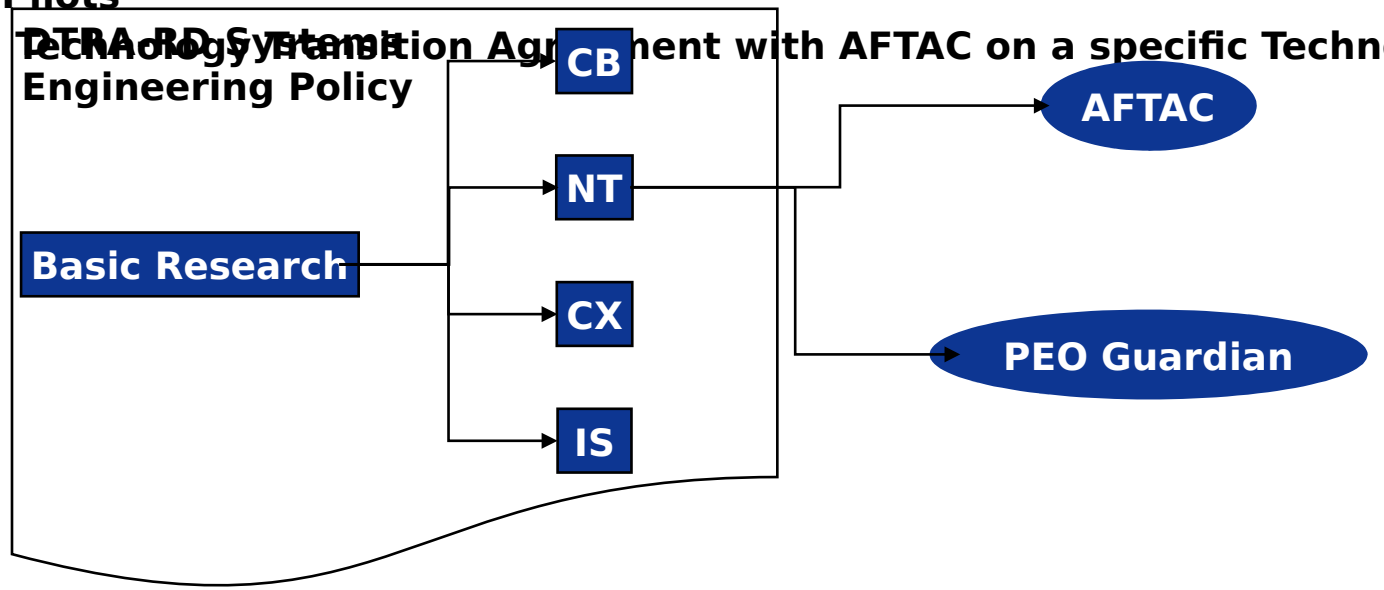
- **Develop/Implement Standard Metrics for use in Measuring Progress using the DTRA/NTD Process. Perform Quick-Look Assessment for Detection Projects and Baseline in TPMM.**

Systems Engineering

- **Drafting DTRA-RD Systems Engineering Policy and developing strawman Technology Maturity Assessment Process for use as Formal Gate Review.**

Transition to Customer Pilot(s)

- **Developing Generic Transition Process between PEO Guardian and DTRA-RD including Pilots**
- **Executing Technology Transition Agreement with AFTAC on a specific Technology Project**



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Overview Summary

- TPMM is an ***activity model*** for technology development that is partitioned into phases and gate-qualified using ***TRL's***.
- TPMM is a ***best practice standard*** that expands TRL understanding to include ***detailed activities, exit criteria, and deliverables***.
- TPMM is a ***toolset*** used by the Tech Manager to ***plan, guide and measure*** a technology program's development maturity.
- TPMM is an ***alignment mechanism*** that promotes early focus on ***transitioning the technology*** to Acquisition Program Customers.
- TPMM acts as a ***common yardstick*** and provides the criteria for evaluating the ***Technology Development Strategy*** earlier.
- TPMM model provides ***a standard TRL criteria set*** for performing ***effective Technology Readiness***

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Contact/Consultation Information

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Ft. Belvoir, VA
E-mail: dian.hall@dtra.mil

US Government Personnel can request a copy of TPMM V2.pdf file at:

http://www.tpmm.info

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QUESTIONS?

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BACKUP

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DTRA-RD Systems Engineering Policy [DRAFT]

DTRA DIRECTIVE XXXX.X

SUBJECT: Defense Threat Reduction Agency (DTRA) Research and Development (RD) Enterprise Systems Engineering (SE) Process Model

References:
(a) DoD Directive 5000.1, "The Defense Acquisition System," May 12, 2003
(b) DoD Instruction 5000.2, "Operation of the Defense Acquisition System," April 5 2002
(c) AT&L Memorandum, "Policy for Systems Engineering in DoD," February 20, 2004
(d) AT&L Memorandum, "Implementing Systems Engineering Plans in DoD - Interim Guidance," March 30, 2004
(e) AT&L Memorandum, "Policy Addendum for Systems Engineering in DoD," October 22, 2004
(f) Technology Program Management Model (TPMM) Version 2 dated September 2006
(g) DoD Instruction 3210.1, September 16, 2005

TPMM Added as a Reference to the DTRA-RD Systems Engineering

A. PURPOSE

This Instruction establishes Defense Threat Reduction Agency (DTRA) Research and Development Enterprise (RD) policy, prescribes procedures, and assigns responsibility for Systems Engineering development and execution.

B. APPLICABILITY

This Directive applies to all RD Directorates responsible for managing programs beyond the Basic Research level for developing technology solutions to validate operational requirements.

C. DEFINITIONS

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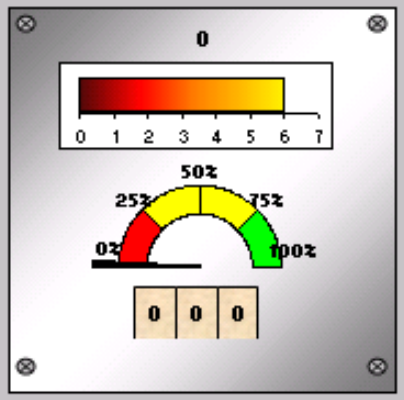
TRL 6 Quick-Look Assessment Checklist [DRAFT]

Project:		TRL:	6		



TRL 6 Quicklook Worksheet

Mnemonic	Description	Yes	No	N/A	Comments	Response
	Program Management					
66211	Technology has been assessed at TRL 6.	□	■	□		
56017	The technology program development strategy has been Finalized	□	■	□		
66047	Provide an estimate of the costs for Transition and Technology Integration into Acquisition Program	□	■	□		
66048	A realistic estimate total life-cycle costs have been documented	□	■	□		
66035	A Risk Mitigation plan has been documented and reviewed by the Programmatic	□	■	□		
13040	The Technology Advancement Degree Of Difficulty has been revised based on the validation process.	□	■	□		
	The Delivery Baseline is established and under formal Configuration control	□	■	□		
	All Corrective Actions are closed or resolved for closure	□	■	□		
	Software Development Cost projections for the Transition phase are updated in the TDS	□	■	□		
	Technical Management					
35009	Refined Operational And Mission Requirements/Objectives were finalized	□	■	□		
35015	System Functional Requirements were finalized	□	■	□		
66030	Specific performance goals and exit criteria that must be met before exceeding number of prototypes were met	□	■	□		

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TPMM Seminar Series

TPMM Naked
Thurs, 28 Jan
0830-1000 hrs

TPMM and the Myth of the Grape Kool-Aid
Thurs, 25 Feb
1400-1530 hrs

TPMM - Combat Training
Weds, 17 Mar
1400-1530 hrs

Turbo TPMM
Weds, 3 Mar
1400-1530 hrs

Endorsed by Defense Acquisition University (DAU) as a "best practice"

Technology Project Management Model (TPMM)

- Improves program execution
- Facilitates program review and prioritization
- Aligns capabilities and identifies gaps
- Reduces risk
- Improves investment decisions
- Can be tailored to meet organizational needs
- Defines key decision points to evaluate progress
- Incorporates organizational processes and systems
- Enhances documentation process
- Supports technology transition

Join Us As We Explore a Focused Approach To DTRA Technology Development

TPMM Pilot Underway in RD-NT

* All seminars will be in **Conf Rm K**

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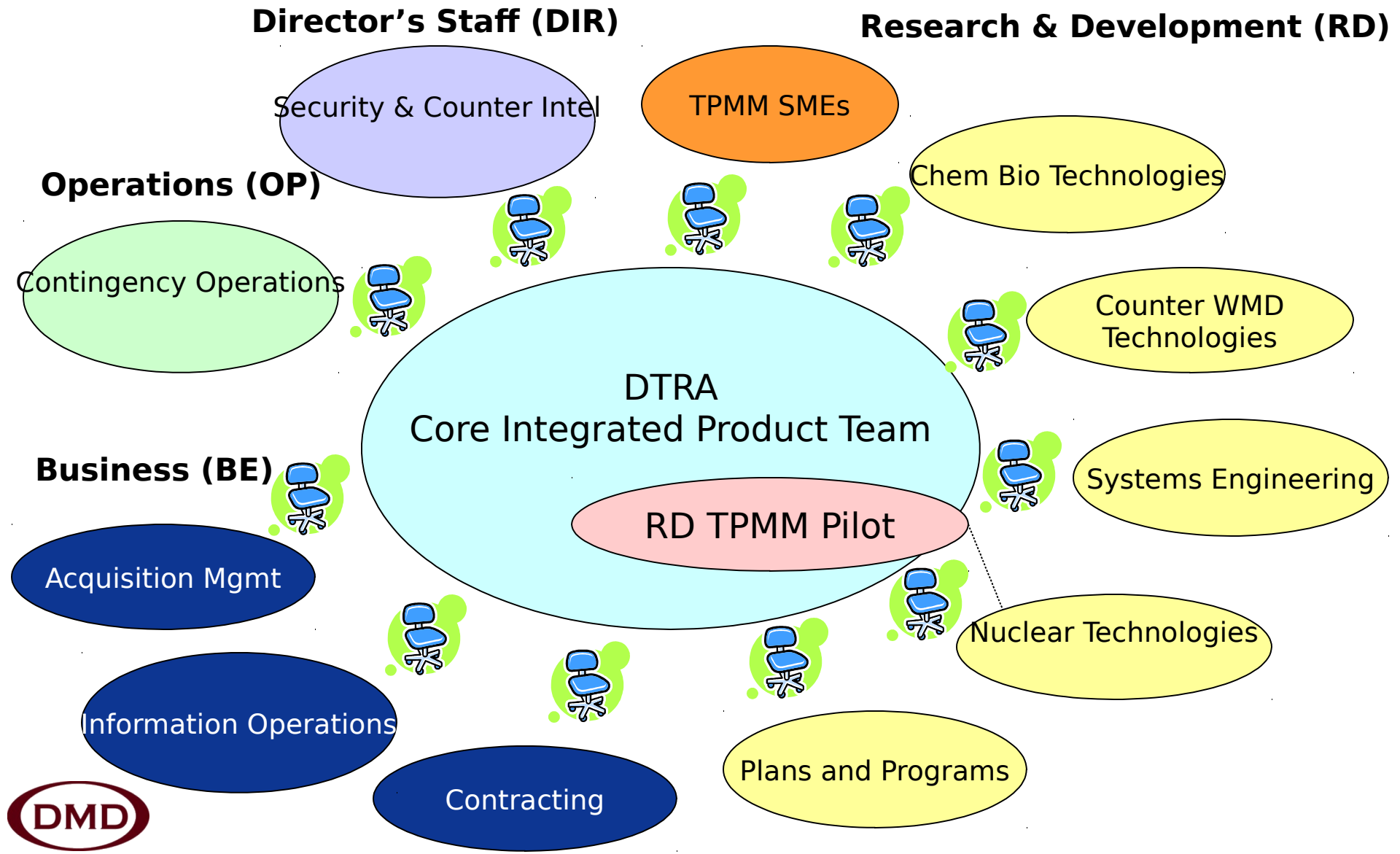
DTRA TPMM IPT

[NOTIONAL]



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Program/Project Status Quad Chart (Notional Tech Program Metrics)

Program Description

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Current Technical Status

TRL Rating Based on TPMM

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- Gap Analysis (on Un-Met)

Cost & Schedule Progress

Technology Development Strategy

- Schedule Milestone Items
- Cost vs. schedule

Risk

- Risk Assessment on Gaps

Program Vision to Transition

TRL Roadmap

- TRL Milestone Schedule to transition

Transition Management

- Customer/User/Sponsor ID'd
- TTA Version (Interest, Intent, Commitment)

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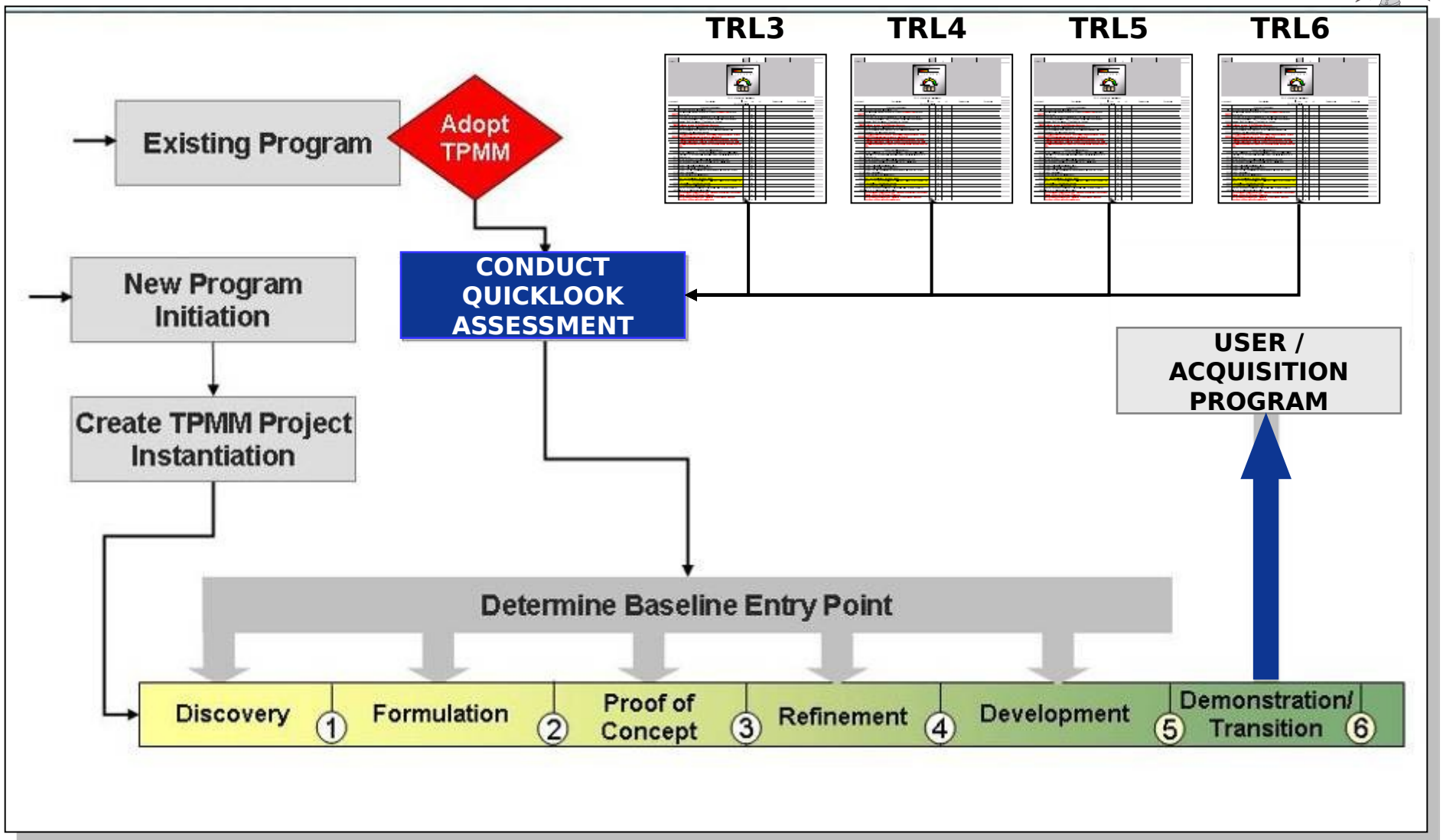
TPMM Entry Process



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Tech Project Gap Report [DRAFT]

Demonstration/Transition Phase Planning			
Mitigated Risks			
Category	Exit Criteria	Justification Type	Justification Status
Demonstration/Transition Phase Planning			
Program Management Planning			
Systems Engineering Planning	The threats to the warfighter addressed by the technology were accurately documented	Justification Applicable Future	Date: 1/15/2010
Requirements Update Planning			
Design Update Planning	Document the electrical and mechanical interfaces for this spiral or increment of development	Justification Applicable Future	Date: 12/15/2009
	Provide the detailed design drawings necessary for this spiral or increment of development	Justification Applicable Future	Date: 12/15/2009
	Provide updated design techniques and codes to be used during this spiral or increment of development	Justification Applicable Future	Date: 12/15/2009
Manufacturing Planning			
Relevant Environment Validation Planning	Document the overall test plan for this phase of development	Justification Applicable Future	Date: 1/15/2010
	Identify Test instrumentation required	Justification Applicable Future	Date: 1/15/2010
	Identify and briefly describe and special test equipment required for a specific test	Justification Applicable Future	Date: 1/15/2010

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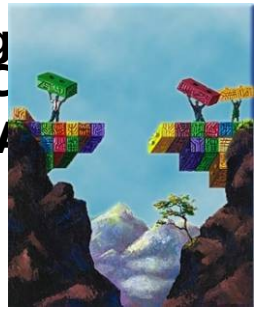
TPMM Strategic Value

Status of Programs

- Standardizes Progress in Meeting TRL Maturity Goals
- Transition Agreements in place
- Successful Transitions over time
- Program Distribution by
  - TRL
  - Technology Domain
    - Science Discipline
    - Sponsor
  - Acquisition Customer
  - Funding

Facilitate Strategic Planning

- Technology Distribution and Prioritization
- Technology Development Gap Analysis
- Domain Analysis
  - Skill gaps / recruiting (Develop/Maintain TC
  - Diversified Portfolio A
    - Sponsor
    - Science Discipline
- TTA Migration Status
- Develop POM/Budget Inputs
  - Substantiates Technology maturity and value



TPMM Provides a Metrics-driven Process that Supports Strategic Decision Making

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TPMM Phase Deliverables

TRL	①	②	③	④	⑤	⑥
	Discovery	Formulation	Proof of Concept	Refinement	Development	Demonstration/Integration Transition
Programmatic	• Schedule & funding for	**Programmatic** • Schedule & funding for	**Programmatic** • Program cost Estimation • Pgm Schedule developed • Contract	**Programmatic** • WBS • Cost Model • TDS • Manufacturin	**Programmatic** • LCcMP • WBS (+) • Cost & risk performance	**Programmatic** • LCC • Transition agreement • Cost & Risk
Technical • Tech Concept Developed • Industry Analysis • Academic Studies	**Technical** • Trade studies conducted • Tech difficulty established • Alternatives analyzed	**Technical** • Req Doc developed w/ (ICD) • Cross tech • Proof of concept analysis • M&S developed	**Technical** • SEP • F3 parameters • System resource allocations • Design constraints • Integrated Lab Test of "ad hoc" or Breadboard	**Technical** • Demonstrate components work with/as system • Test with other elements in HF Validation test • Develop high fidelity component or Brassboard "HWIL"	**Technical** • Demonstrate Prototype Ready for Operations • Produce Proto Hardware for a Relevant Env • Test Prototype as System in Simulated Operational Setting • Demonstrate
Transition • ID Potential Stakeholders	**Transition** • ID specific customers	**Transition** • Sponsor	**Transition** • Stakeholders briefed (Customer/	**Transition** • Detailed Transition Planning and	**Transition** • Transition agreement signed
Deliverables	**Deliverables**	**Deliverables**	**Deliverables**	**Deliverables**	**Deliverables**
Feasibility Study Formulation Plan	Analysis of Technical Alternative Formulation Analysis Report Proof of Concept Plan	Proof of Concept Technology Development Strategy (TDS) Initial Technology Transition Agreement (TTA) Breadboard Lab Validation Plan	Breadboard Lab Validation TDS Update TTA (Intent) Brassboard Lab Validation Plan	Brassboard Lab Validation TDS Update TTA Update (Intent) Manufacturing Plan [Draft] Prototype Relevant Env Lab Validation Plan	Prototype Relevant Env Lab Validation TDS Final TTA Update (Commitment) Manufacturing Plan [Final]

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